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REPORT

ON

Soils, etc., in Central Park

New York City

Submitted May 15, 1911

TO

Hon. CHARLES B. STOVER

Commissioner of Parks, Boroughs of Manhattan and Richmond

BY

GUSTAVUS B. MAYNADIER

INTRODUCTORY NOTE

The origin and purpose of this report are briefly set forth in my letter of May 16, 1911, transmitting the same to the Hon. William J. Gaynor, Mayor, as follows:

In the five-year Corporate Stock Budget, which I was directed to submit to the Board of Estimate and Apportionment, on or before December 15, 1910, is found the following item:

Restoration of Central Park: The work of reshaping the lawns, depositing new top soil, sodding, planting and otherwise improving the park, \$1,250,000.

The authority I relied on at that time for this submission was Mr. Samuel Parsons, then our Landscape Architect. Already, however, before December 15, 1910, my faith in Mr. Parsons' resoiling scheme was being shaken, and I determined to look outside for advice.

This I did December 5, 1910, in a letter to Professor Milton Whitney, Chief of the Bureau of Soils, U. S. Department of Agriculture. To this letter Professor Whitney replied on December 28, 1910, that my request of December 5th had been held, pending a full consideration of the matter with the Secretary of Agriculture, and he added:

"I am authorized by the Secretary to inform you that he has every desire to assist you in any possible way. He authorizes me to inform you that if you desire the services of one of our soil men, he will arrange a furlough and turn the man over to you for such time as you may need him and at such compensation as you may decide to give him. Of the available and experienced men of the Bureau of Soils, I think that probably Mr. G. B. Maynadier, at present in charge of a soil survey party in Mobile County, Ala., has perhaps the best experience for that kind of work."

Later in a letter dated January 7, 1911, Professor Whitney wrote:

"I still think that Mr. Maynadier is the best-posted man who is available in the Bureau of Soils."

My faith in the resoiling scheme became more and more undermined, until on January 27, 1911, I informed every member of the Board of Estimate and Apportionment, that the \$1,250,000 item in the Corporate Stock Budget "is only a tentative estimate," and I concluded:

"I have already taken steps to secure the best scientific advice, to the end that this ancient resoiling question may once for all be disposed of in a manner that will receive the approval of all public-spirited and well-informed citizens."

Mr. Maynadier arrived here in March and on the 3d of that month I gave him this instruction:

"In the investigation of the soil and plant conditions of Central Park, which you will this day begin to make for the Park Department, I give you but one instruction, namely, to follow the good old rule of getting at the truth, the whole truth, and nothing but the truth; so the City authorities will best be enabled to do their duty well, in respect to this great park."

CHARLES B. STOVER,
Commissioner, Department of Parks,
Boroughs of Manhattan and Richmond.

Report on Soils, etc., in Central Park, Submitted May 15, 1911,
to Hon. CHARLES B. STOVER, Commissioner of Parks,
Boroughs of Manhattan and Richmond, by
GUSTAVUS B. MAYNADIER

The conditions at present existing in Central Park are by no means of recent origin. They have been the subject of several investigations, and many recommendations for their betterment have been made as a result of these investigations, but few of which have been acted on.

In 1902, a Committee consisting of Messrs. N. L. Britton, B. E. Fernow, J. A. Pettigrew and Samuel Parsons, Jr., made a thorough investigation, and the following extracts from their report are presented for your consideration.

After describing the methods used in making their examination, this Committee says of the soil, that it is to an average depth of 10 inches, a good loam underlain to a depth of about 3 feet by a subsoil of the same general character as the surface soil, but containing less organic matter. In support of their opinion of the quality of the soil, the report states:

“This is attested by the trees themselves which show vigorous growth in the open places and in the natural forests.

“The original plan of a park plantation made for immediate effect always contemplates the necessity of timely changes by the removal of trees originally planted much closer together than they are intended to stand finally. The primary and principal cause of the present condition of the trees in Central Park is the lack of thinning out * * *. The trees should have been thinned out at least twenty years ago * * *. The shrubberies are generally in a dilapidated condition. The growth is spindley and weak, the result of overcrowding and lack of proper cultivation, fertilizing and renewal.”

The recommendations of this Committee were, in brief:

1. Thinning out of all surplus, diseased and crowded trees.
2. Removal of short lived trees and those not suitable for city conditions, together with a reduction of the amount of California privet.
3. Careful and competent pruning and protection of cut surfaces.
4. A clearing out of all trees, shrubs and herbaceous plantations in open glades and from bays in the foliage lines; also the removal of all incongruous material which disturbs the harmony of the landscape.
5. Allow fallen leaves to remain in shrubberies and woodlands, and to spread those raked from ornamental grounds over the woodlands.

6. The regular application of manure and commercial fertilizers to the groves, plantations and lawns, and the addition of top soil in certain limited areas in which the rock comes close to the surface where new shrub planting is to be done, and in some of the existing dilapidated shrubberies; on The Mall, the application of 4 inches of manure mixed with potash, to be spaded in.

7. Plant and thicken border plantations where necessary.

8. Improve margins of woodlands by appropriate plantings, etc.

9. Modify or reconstruct shrubberies, many require replanting after first thoroughly preparing the ground.

10. The construction of a system of water distribution for the irrigation of lawns and newly planted grounds. * * *

Signed by—

N. L. BRITTON,

B. E. FERNOW,

J. A. PETTIGREW,

SAMUEL PARSONS, JR.

To carry out the work as recommended, \$50,000 will be included in the request for funds to be provided in 1903.

As will be seen in the report, the soil is spoken of as "good loam to a depth of 10 inches" and this is "attested by the trees themselves."

The chief criticism in this report is not directed against the soil or soil conditions, but generally against the system of management that had prevailed in this Park. This is very clearly stated in the report itself. In referring to the condition of the shrubberies, it specifically states that their present (1902) condition is the result of overcrowding and "lack of proper care, cultivation, fertilizing and renewal."

The specific recommendation of the "addition of top soil in certain limited areas, etc.," and the further recommendation relative to application of manure mixed with potash on The Mall, are too definite to admit of misunderstanding.

Notwithstanding the clear and definite recommendations of this Committee, in regard to the soil needs of The Mall, nothing seems to have been done in this direction, and the further recommendations regarding the use of fertilizing material have been but partly carried out.

It is clear that at this time the idea of extensive resoiling, a proposition since brought prominently to the front, even if considered at all, was not deemed worthy of mention in the report. The first recommendation for resoiling Central Park was made in 1907.

These plans as reported in the public press of October 10, 1907, "comprehend the removal of all sod and shrubbery and many of the trees" and the further statements are made:

"Its (the park) soil needs renovating. The park is now over fifty years old and most of its trees have reached and passed their maturity."

For renovating this soil the estimate is made of a requirement of 75,000 yards of "mould" to cover 20,250,000 square feet six inches deep, and 75,000 cubic yards of manure. Just why the manure alone, if properly applied would not suffice, is not stated. And the trees that in 1907 are characterized as being over fifty years old and as having passed their maturity, are the same ones whose vigorous growth in 1902, five years previous, was cited in support of the statement that the soil was a "good loam."

The examination of the conditions in Central Park by Messrs. Wilder and Reid of the Bureau of Soils in 1908 states, in part:

"The surface of Central Park, New York, is rolling and presents a variety of soil conditions. The depth of the soil covering varies from a few inches in the vicinity of rock ledges to a depth of several feet in the hollows." * * *

"The areas devoted to grass plots are vigorous in some places, but needing attention in others."

"Another unfavorable condition, which has probably arisen as a result of maintaining lawns for a considerable period of time, is the advent of various species of grasses such as redtop and orchard and other stooling grasses, together with annual grasses and various weeds." * * *

"The trees in the park are in most cases well established and have made a very good growth, although considerable effort is required to maintain them in a sufficiently healthy condition." * * *

"Wherever poor soil materials lie too near the surface, it will be necessary to apply further surface covering. Such cover material should be selected with great care and should not only have been productive where it originally occurred, but also of such character as to blend well with the surface material already within the park.

"It will be apparent from this that each unit area, say one-fourth acre, should be prescribed for individually, for instead of a uniform cover which supplies more soil than is needed in some places and less than is needed in others, the same total application or even a smaller one would bring far more efficient results.

"The open areas have generally been left in sod so long that there is some difficulty experienced in keeping them smooth and in retaining desirable grasses and eliminating undesirable ones. The first difficulty might be alleviated somewhat at least, by rolling the ground when moist, but not soggy. The second difficulty can best be solved, it is believed, by a judicious introduction of some tilled crop for a brief period, such as potatoes or corn, the former being less objectionable, possibly, to the public because less obstructive to the view. Then, when the soil has been well manured with stable manure, for which arrangements have been so well provided in this park, thoroughly subdued and put in good tilth by the processes of cultivation, it will be in good condition for reseeding, with reasonable assurance of re-establishing for a considerable period a lawn of great attractiveness." * * *

As will be seen, this report distinctly states that an addition of soil is desirable only "wherever poor soil materials (rock, miscellaneous material used for filling, etc.) lie too near the surface," and is equally emphatic against the deposition of a uniform layer over extensive areas which would result in supplying "more soil than is needed in some places and less than is needed in others." Attention is also called to the recommendations

regarding the use of stable manure, the introduction of tilled crop for the subjugation of weeds and reseeded to grass for re-establishment of the lawns.

In 1910 an examination of the conditions in Central Park was made by the Central Park Restoration Committee of the Parks and Playgrounds Association. This report is the result of an inquiry covering six months, and is, in part, as follows:

“Regarding the item of resoiling, for which \$250,000 is asked, to be provided annually for five years, so many conflicting rumors have been current regarding this great question that the Committee has had sixty samples of soil taken, covering the entire park; see enclosed certificates of analysis, also key to the location of points where each sample was secured, shown on accompanying map. Thirty-one of these samples were assayed individually, and the rest thoroughly mixed and a single assay made of the mixture. Twelve samples were sent to the United States Agricultural Department, and reports when received will be submitted. These assays show the presence of about 4½ per cent humus, and about 19½ per cent clay. Soil in Central Park should contain 33 per cent clay to overcome the loose character of soil given by the great percentage of sand—and not less than 12 per cent humus. If a top soil of 46½ per cent clay and 19½ per cent humus should be added to the present soil and thoroughly plowed in, and so mixed with the old soil, a percentage of 33 per cent clay and 12 per cent humus would be obtained and an almost perfect soil secured.

“Each of these soil samples was taken by an expert, witnessed by a representative of this Committee, and the Government test is being made from twelve of these.” * * *

“Central Park is rich in rare and valuable trees, but they are as a whole suffering from lack of scientific pruning, of competent tree surgery, and erosions about the roots, exposing them to the sun, bruising and all sorts of injury.

“The above conditions have resulted in the loss of many valuable trees, and a great many others will soon follow unless immediate relief is given. The vitiated soil surrounding the roots of the existing trees should be removed and replaced with nutritious and suitable soil.

“We recommend that an up to date and scientific method of tree surgery be introduced. Central Park trees lose their foliage a month to six weeks earlier than the trees of outlying parks.

“The shrub life in the Park is suffering from old age, lack of water, and bad or no pruning, and examination has convinced us that 90 per cent of it has outlived its usefulness and will have to be replaced within the next five years.” * * *

“Although water is most essential to plant life, Central Park is to-day without an efficient system for proper maintenance. * * * Through the lack of water thousands of shrubs died outright. Quantities of trees will show the drought by the dying of limbs, even to the extent of half a tree, and so practically destroying a great many trees.” * * *

“This Committee has been particularly impressed with the inefficiency of the Park machinery for maintenance, and respectfully urges that this Honorable Board will so arrange its appropriations that the machinery for maintenance may be perfected immediately; that such sums shall be appropriated as will enable the Park Department from year to year to completely restore the Park to its proper and natural condition.”

I heartily agree with the report of this Committee in its statements concerning the necessity for the extension of the water system in the Park, which is a matter of prime necessity; it is hard to conceive that this much needed work should have been neglected. Just how the Committee reached its conclusion that the removal of what they term "vitiating soil" surrounding the roots of existing trees and its replacement with nutritious and suitable soil, would remedy conditions that they had already pronounced as resulting from lack of water which they distinctly state was responsible for the death of thousands of shrubs and the destruction of many trees, is difficult to understand. They also lay stress on the fact that the shrub life in the park is suffering from old age, lack of water, and bad or no pruning. The extreme age that the shrubbery has reached, in spite of the serious drawbacks enumerated, is in itself strong testimony in favor of the soil in which they grew to their present advanced state.

In its discussion of the soil of Central Park, this Committee finds that the existing soils contain about 19½ per cent of clay and 4½ per cent of humus, and recommends that a top soil containing 46½ per cent of clay and 19½ per cent of humus should be added and thoroughly plowed in and so mixed with the old soil; they then add "a percentage of 33 per cent clay and 12 per cent humus would be obtained, and an almost perfect soil obtained."

There is at present, both among some of the officials of Central Park and the many citizens interested in the maintenance of the Park, a very erroneous opinion in regard to "humus"; not only in respect to the amount a soil should contain, but to the nature of the material itself. Moreover, such a soil as they conclude to be desirable to use for improving the soils of the Park, that is a soil containing 46½ per cent of clay and 19½ per cent of humus, would be difficult to manufacture and quite impossible to find in a natural condition. In analyzing a total of 8,664 samples of soil from all over the United States, 1,970 were found to be of such composition as to be properly classified as clay soils, and the average amount of clay in them was found to be 42 per cent, and in 718 clay loam soils 26 per cent of clay was found. (Circular March 22, 1911, Bureau of Soils.)

The humus content of ordinary cultivated lands rarely exceeds 5 per cent, and very commonly falls below 3 per cent (see "Soils," E. W. Hilgard, p. 133). Only in peat, marsh, or muck soils is an amount of humus approaching 20 per cent ever found under natural conditions, and these soils usually contain about 80 per cent of organic matter.

The Committee's report does not state to what depth the soil is to be treated, though to obtain the results demanded the plowing and mixing would have to be of an equal depth as the new layer of soil supplied. If this depth were six inches as recommended in the report of 1907, it would mean an attempt to thoroughly mix these soils to a depth of 12 inches by the use of the ordinary implements of tillage which would be found to be quite impossible of success. The result most likely to follow would be that the added soil would be distributed throughout the existing

soils in masses of various size which would add only to the unevenness of the soil structure, and not give the desired improvement. Moreover, the Committee has overlooked the important fact that a soil must contain a proper proportion of various materials, other than clay and humus to be considered the almost perfect soil that their report mentions. A soil with certain proportions of these materials, and the balance coarser sands, is very different from one with the same amount of clay and humus and the remainder silt and finer sands.

The Committee states in its report that the average amount of humus found in the soils examined was about $4\frac{1}{2}$ per cent. The Committee is in error. The analysis shows about that amount of organic matter, or, as it is in some cases reported—organic humus material, a portion of which will eventually become humus, but which in the condition reported, is by no means humus and must not be confounded with it.

This amount of organic matter is considerably in excess of that usually found in soils, which Cameron of the Bureau of Soils, found to average about 2.06 per cent in surface soils to a depth of 8 inches, and .83 per cent in subsoils. This means about 28 tons per acre to a depth of 8 inches and a total of 50 tons per acre to a depth of 2 feet.

Much has been said regarding the fitness of the soils of this park for the support of a growth of grass and it is frequently asserted that the soil is not a "grass soil."

Soils are spoken of as grass or wheat or fruit soils, because of a general adaptation for the production of these crops under ordinary agricultural conditions. These adaptations are usually of a somewhat general nature, and it should not be thought that a soil designated as a good wheat soil will grow nothing but wheat. It means that such a soil has qualities that peculiarly fit it for wheat, as distinguished from the qualities possessed by other soils, or by it for other crops. What are usually termed, in this agricultural sense, as grass soils are usually somewhat more dense than the soils found in Central Park, that is, they contain a larger proportion of clay. This has led to the unwarranted assumption that the Park soils are not capable of producing a good growth of grass, and the present condition of the lawns is attributed wholly to this fact. In consequence of the often repeated statement that the soils of Central Park are not suited to grass, or that they are completely worn out, the impression has been created that they are in this condition, and that but one thing should be done, and that is to replace the soil of the Park with a new soil. This is by no means the case.

The Committee from the Parks and Playgrounds Association, took a number of soil samples from various parts of Central Park, twelve of which were submitted to the Bureau of Soils of the United States Department of Agriculture, by Mr. Gutzon Borghum, the Chairman of the Committee.

In the Committee's report it is stated: "Each of these soil samples was taken by an expert, witnessed by a representative of this Committee." The disinterestedness of the Committee is beyond question, but I do not think the results of these analyses warrant the conclusion that the Park requires "resoiling," which they appear to have reached.

The present system of soil classification contemplates the presence in a loam soil of 50 per cent or more of clay and silt taken together, the total, however, to be less than 70 per cent, of which not to exceed 20 per cent is clay, with less than 50 per cent of silt, the remainder being made up of the various grades of sand. The requirement for a fine sandy loam is that it shall contain 50 per cent or more of fine sand, with less than 20 per cent of the coarser grades of sand, and about 25 per cent of silt and clay together.

These results are based on a large number of analyses of soils of these types from various parts of the country.

The analyses of ten (10) of the twelve (12) samples of soil submitted from Central Park, gave the following results:

No.	Depth.	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Clay.
(5)	12 inches	2.1	5.3	5.6	16.9	20.9	36.3	13.2
(10)	" "	2.3	4.4	5.	20.2	21.3	33.9	12.7
(15)	" "	3.9	4.8	4.3	14.4	19.8	38.1	14.9
(20)	" "	.9	1.9	2.2	22.3	25.1	32.6	14.7
(25)	" "	3.8	8.7	7.5	20.7	14.3	30.7	13.8
(30)	" "	3.4	5.9	5.4	13.5	20.6	35.8	15.3
(45)	" "	1.2	3.5	3.4	14.3	13.6	45.7	17.8
(50)	" "	3.4	7.4	6.4	14.3	13.9	40.1	14.3
(55)	" "	2.3	7.1	6.1	16.6	16.2	39.8	11.8
(60)	" "	2.8	7.7	6.4	10.4	15.7	38.8	17.7

As will be seen by an examination of these figures, the soils of Central Park occupy a somewhat intermediate position between the two types which is more clearly shown below:

No. of Samples.	Soil.	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Clay.
934	Fine Sandy Loam	1.	3.	4.	32.	24.	24.	12.
10	Central Park	2.6	5.7	5.2	16.4	18.1	37.2	14.6
659	Loams	2.	5.	5.	15.	17.	40.	16.

In the soils of the Park, the slight excess of sandy material over that found in a loam soil is proportionately less than the increased amount of silt and clay contained in them over that contained in a fine sandy loam soil. Moreover, the requirement in soil classification is that a fine sandy loam shall have 50 per cent or more of fine sand with 20 to 50 per cent of silt and clay, and that a loam shall contain less than 20 per cent clay, and, at least, 50 per cent of silt and clay together.

An examination of the results of the analyses of these samples shows:

Sample No.	5	10	15	20	25	30	45	50	55	60
Total clay and silt.....	49.5	46.6	53.	47.3	44.5	51.1	53.5	54.4	51.6	56.5
Total fine and very fine sand.....	37.8	41.5	34.2	47.4	35.	34.1	27.9	28.2	32.8	26.1

It will be seen that in all cases but one (No. 20) the total amount of silt and clay in the park soils, is in excess of the amount of the finer sands, and those that do not entirely meet the requirements of a loam soil very nearly approach the standard set for that type. In no case, however, does the amount of fine sand and very fine sand reach the proportion necessary for a fine sandy loam.

The remaining two of the twelve samples analyzed gave the following results, with which is presented the average of 1,141 samples of sandy loam, for comparison, a soil to be classed as a sandy loam should contain from 20 per cent to 50 per cent of silt and clay, together with 25 per cent or more of fine gravel, coarse and medium sand.

	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Clay.
Park No. 35.....	6.4	10.3	8.	17.6	16.8	31.	9.
Park No. 40.....	2.4	7.9	7.8	23.2	24.3	22.7	11.5
Average of 1,141 samples..	4.	13.	12.	25.	13.	21.	12.

It will be noted that in these two instances the total amount of silt and clay is greater, and that of the coarser materials (fine gravel, coarse and medium sand), less than the average of the 1,141 samples used to establish the type. The presence of 24.7 per cent and 18.1 per cent of these materials may, however, warrant these soils being classed as sandy loams.

During the prosecution of the present investigation, samples of soil were taken in different areas in the Park and submitted for analysis. These samples consisted of 21 samples of surface soil taken to a depth of about 10 inches, and 12 samples of subsoil. The samples of subsoil were taken to a depth of 3 feet, except in case stone or underlying rock prevented. In the cases of numbers 10, 24 and 37, the borings frequently reached rock filling or the disintegrating underlying rock, which accounts for the high percentage of very coarse materials in these samples. This is the result of the original construction of the Park, when less care was observed in the selection of material for filling than probably would be exercised were the work done at the present time. In the main the texture of the surface soil is very similar to that of the subsoil, as far as the fine earth is concerned, the stones, gravel, etc., having been largely removed when the grading of the lawns was completed. This fact was noticed by the investigators in 1902, who say in their report:

“The soil to a depth of 10 inches is a good loam underlain to a depth of about 3 feet by a subsoil of the same general character.”

The following table shows the result of the mechanical analysis of the samples of soil taken during the present investigation:

MECHANICAL ANALYSES OF SOILS OF CENTRAL PARK.
(Fine Earth.)

No.		Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Clay.
(1)	Soil	2.7	6.9	5.3	13.1	14.7	41.3	15.3
(2)	Subsoil	2.3	7.4	5.4	14.1	13.8	43.5	13.4
(3)	Soil	3.4	11.6	8.7	18.9	13.4	31.1	12.4
(4)	Soil	2.6	4.7	3.9	17.3	22.9	36.0	12.0
(5)	Soil	3.4	6.2	5.5	15.6	15.6	34.9	17.9
(6)	Subsoil	2.1	5.3	5.5	14.7	14.5	41.7	15.7
(7)	Soil	1.8	4.8	4.1	13.3	16.5	42.7	16.3
(8)	Subsoil	2.1	5.7	4.8	24.4	10.9	38.3	13.4
(9)	Soil	2.4	7.9	6.0	18.5	14.4	35.8	14.8
(10)	Subsoil	6.4	15.4	9.9	19.5	10.2	28.5	9.8
(11)	Soil	3.1	7.3	5.6	15.9	17.5	34.2	16.2
(12)	Subsoil	1.9	6.1	5.4	14.7	13.6	45.7	12.4
* (13)								
(14)	Soil	3.4	6.9	6.2	13.5	13.9	40.8	14.9
(15)	Soil	2.6	5.4	4.7	12.8	15.2	46.3	12.3
(16)	Soil	1.2	3.1	2.9	17.2	22.5	44.0	8.7
(17)	Subsoil .....	.0	1.3	1.2	9.1	40.2	41.5	6.7
(18)	Soil	1.6	4.9	4.5	14.2	13.5	44.8	15.7
(19)	Subsoil	2.1	5.0	5.0	15.3	17.4	41.3	13.3
(20)	Soil	2.1	8.5	8.2	17.7	14.5	36.5	12.2
(21)	Subsoil	3.6	8.8	6.5	16.7	13.1	39.3	11.7
(22)	Soil	2.5	8.1	5.4	12.6	14.1	44.7	12.0
(23)	Soil	3.5	10.4	5.8	13.9	18.7	35.8	11.4
(24)	Deep Subsoil	9.1	14.4	10.0	22.4	10.2	24.8	8.6
(25)	Soil	1.6	4.0	3.1	15.1	18.3	45.5	12.1
(26)	Soil	1.2	5.6	4.5	11.3	16.5	45.0	15.3
(27)	Subsoil	2.2	6.0	4.8	11.3	14.4	47.8	13.2
(28)	Soil	1.9	4.6	3.4	10.6	23.2	38.7	16.8
(29)	Subsoil	1.9	4.3	4.0	11.3	12.9	54.0	11.5
(30)	Soil	3.3	6.8	5.1	13.1	17.3	42.7	11.5
(31)	Soil	4.3	6.0	4.6	11.8	16.5	44.3	12.3
(32)	Subsoil	2.8	5.3	3.5	10.5	14.8	51.9	10.9
(33)	Lake Bottom	1.6	2.5	1.3	12.3	17.5	55.9	8.1
(34)	Soil	2.4	5.3	4.2	12.2	21.2	42.6	11.4
(35)	Subsoil	3.7	6.7	5.5	13.8	13.5	48.0	8.5
(36)	Soil	3.1	8.5	8.0	19.3	16.6	34.3	9.5
(37)	Subsoil	5.0	12.5	7.1	22.6	14.5	29.1	9.0

* No analysis of No. 13.

Of these, 21 samples are of surface soil, of which 17 contain over 50 per cent of silt and clay together, and may properly be considered loam soils. Two (Nos. 23 and 30) samples fall but little short of this requirement, containing 48.7 and 47.2 per cent, respectively. These, however, meet the requirements for loam soils more nearly than they do those for either the sandy loam or fine sandy loam types. The presence of 23.7 per cent of the coarser material would probably impart some of the characteristics of a sandy loam, to one sample (No. 3). When it is considered that there is but 32.3 per cent of the finer sands present, this soil may properly be considered a sandy loam, rather than a fine sandy loam. The remaining sample, No. 4, is intermediate between the established types, but the silt and clay content, amounting to 48 per cent, falls but little short of that requisite for a loam soil.

The subsoils, while of very similar texture to the surface soils, are as a rule a trifle heavier. The exceptions being in the soils from the old Ball Ground, the South Meadow, the area on the east side from 97th to 102nd Streets, and the west side of the North Meadow. As will be seen in the case of samples 28 and 29 (east side from 97th to 102nd Streets) the subsoil is sufficiently high in silt to make up for the deficiency in clay. These analyses, however, support the statement made in the report of 1902. As a rule, natural subsoils are heavier than the surface soils, and all authori-

ties agree that a reversal of these conditions should be guarded against in lawn construction. To add a depth of six inches of a heavy clay loam to the surface layer of these soils, as has been advocated, would be but to increase the existing differences, where the present subsoil is lighter, and to bring about an undesirable condition when the texture of soil and subsoil is the same.

In a recent publication issued March 18, 1911, the authors, Messrs. Schreiner and Skinner, referring to loam soils, say on page 15:

“A productive loam, that is, one having good drainage and containing sufficient organic matter to maintain a good loamy tilth, with a good permeable subsoil, neither excessively sandy nor clayey, will make a good lawn.”

And in discussing sandy loams on page 17, state that

“Soils of this texture make very good lawns when well drained, well supplied with organic matter, and where underlain by a clay or sandy subsoil, sometimes even rivaling the clay loam or silt loam in adaptability to lawn grasses.”

They further say concerning the Fine sandy loams:

“Soils of this texture are very similar (to the sandy loams) in their adaptability to lawn-making and have even a greater water-holding power.”

The following table gives the average analyses of soils, which in their experience, these gentlemen have found to be suitable for lawns. These are presented with the Park soils for comparison:

	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt.	Clay.
Central Park, 10 samples							
Loam	2.6	5.7	5.2	16.4	18.1	37.2	14.6
Loams, 3 soils.....	2.	8.	7.	14.	13.	42.	15.
Central Park, 2 samples							
Sandy Loam	4.4	9.1	7.9	20.4	20.5	26.8	10.2
Sandy Loam, 2 soils.....	1.5	11.5	15.5	26.	9.	25.	11.5
Fine Sandy Loam, 2 soils..	1.	3.	5.	38.5	24.	20.	8.

It is evident from the observations made by the authors of this bulletin, that good lawns can be made and maintained on soils of varied composition, with all of which the Park soils compare favorably in every respect. Their experience with the sandy loam, as recorded on page 17, previously referred to is amply borne out by the growth of blue grass on the lawn west of the Museum of Art, which, where free from intrusion by weeds is as thrifty as could be desired. (See Bulletin 75, U. S. Dept. Agriculture, Bureau of Soils, Lawn Soils, by Oswald Schreiner and J. J. Skinner.)

The analytical results show the soils of Central Park to be texturally well suited for lawns, and, in my opinion, completely refute the idea that resurfacing the lawns with heavier soil, or resoiling as it is termed, is necessary. Nor does it appear, in view of the recognized relationship in texture that should exist between the soil and subsoil that such treatment is at all proper.

The chemical analyses of the 12 samples, as made in the Laboratory of the Bureau of Soils, U. S. Department of Agriculture, at the request of the Committee on Parks and Playgrounds, gave the following results:

ACID DIGESTION

No.	Lime. CaO	Magnesia. MgO	Phosphoric Acid. P ₂ O ₅	Potash. K ₂ O	Nitrogen. N	Humus.	Humus Ash.	Organic Matter.	Carbon Dioxid. CO ₂
(5)	.39	0.62	0.13	0.36	0.22	1.93	0.45	3.97	0.10
(10)	.36	.59	.15	.26	.21	1.84	.47	4.01	.03
(15)	.51	.63	.23	.24	.21	1.71	.43	3.55	.00
(20)	.28	.36	.11	.20	.21	1.68	.30	3.66	.00
(25)	.29	.58	.12	.27	.18	1.39	.29	2.51	.00
(30)	.40	.81	.13	.35	.21	1.85	.31	3.92	.00
(35)	.48	.90	.13	.82	.13	.84	.33	2.41	.05
(40)	.43	.72	.18	.45	.20	1.46	.29	3.26	.01
(45)	2.22	1.78	.13	.43	.29	2.93	.99	5.83	.03
(50)	.37	.75	.12	.44	.20	1.51	.22	2.83	.00
(55)	1.04	.94	.15	.50	.21	1.56	.29	3.25	.18
(60)	.73	.96	.15	.41	.22	2.68	1.35	3.99	.03
	.625	.803	.144	.360	.207	1.78	.476	3.599	.0358

With the exception of two samples, these soils are shown to be higher in Magnesia (MgO) than they are in Lime (CaO). In this respect the Park soils do not differ from the soils of the Atlantic Coast States generally, where the amount of magnesia has usually been found to be from about the same to about double that of lime, which accounts for the benefits that follow an application of lime to the soils of this section.

From studies made regarding the effect of Magnesia in soils, it has been found that while some plants will do well when the amounts of lime and magnesia are equal, the majority require that the ratio be as 2 or 3 of lime, to 1 of magnesia, to secure the best results. In the cases, Nos. 45 and 55, where the amount of lime is in excess of the amount of magnesia, it falls short of being in the ratio of 3 or even 2 to 1.

As the result of very extensive studies of the chemical relations of soils to plant growth, Hilgard, after investigating the phosphoric acid and potash content of soils, reaches the conclusion that to be adequate the amount of these substances must not be less than .1 per cent of phosphoric acid, and .25 per cent of potash.

In the samples submitted by the Committee, the amounts of phosphoric acid varied between .11 per cent and .25 per cent, giving an average of .144 per cent. The amount of potash present in these samples varied from .20 per cent to .82 per cent; the average being .360 per cent. In two cases the amount of potash was below the minimum of adequacy as determined by Hilgard, the amount present in these cases being .24 per cent and .20 per cent.

The average amount of organic matter in these soils was found to be 3.599 per cent, an amount in excess of the 2.06 per cent found as an average by Cameron. In every case this figure was exceeded, the amounts ranging from 2.51 per cent to 5.83 per cent.

The need of an increased amount of lime in these soils is imperative. Not only is this shown by the amount of magnesia present in them, but by

the growth of many weeds that occur throughout the Park. It is also held by some authorities that in the presence of high lime content, relatively small amounts of potash and phosphoric acid may prove sufficient to give good plant growth.

The following table shows the result of the determination of lime, phosphoric acid and potash, only, in the samples of soil and subsoil collected during the present investigation. Lack of time prevented as full an analysis of these soils to be made, as was done in the case of those submitted by the Parks and Playgrounds Committee, but these determinations showing the amount of the principal mineral plant foods, are interesting in view of the oft repeated statements that the Park soils are exhausted:

No.		Lime. CaO	Potash. K ₂ O	Phosphoric Acid. P ₂ O ₅
(1)	Soil	0.58	0.33	0.14
(2)	Subsoil .....	.48	.35	.13
(3)	Soil .....	.72	.38	.22
(5)	Soil	1.25	.33	.21
(6)	Subsoil .....	.74	.37	.18
(7)	Soil .....	.61	.40	.34
(9)	Soil .....	.48	.35	.18
(11)	Soil .....	.61	.29	.29
(12)	Subsoil .....	.55	.28	.26
(14)	Soil .....	.80	.38	.16
(15)	Soil .....	.49	.07	.15
(16)	Soil	3.48	.16	.20
(17)	Subsoil	1.15	.25	.19
(18)	Soil .....	.37	.17	.19
(20)	Soil .....	.60	.20	.24
(22)	Soil .....	.64	.22	.19
(23)	Soil .....	.66	.15	.10
(24)	Subsoil .....	.63	.27	.16
(25)	Soil .....	.29	.13	.10
(26)	Soil .....	.40	.14	.15
(28)	Soil .....	.40	.28	.26
(29)	Subsoil .....	.45	.30	.20
(30)	Soil .....	.26	.25	.35
(31)	Soil .....	.37	.26	.19
(32)	Subsoil .....	.29	.25	.16
(34)	Soil	2.20	.25	.25
(35)	Subsoil .....	.64	.33	.14
(36)	Soil .....	.75	.34	.19
(37)	Subsoil .....	.43	.25	.13

As will be seen, the range in these soils is somewhat greater than that in the samples taken by the Playgrounds Committee, but on the whole are comparable with them. The average for lime is rendered high by reason of the large amounts present in both soil and subsoil of the samples taken from grounds used for playing tennis, Nos. 16, 17 and 34, upon which white-wash or some similar material has been used for several years, for marking the courts. Omitting these areas, the sample from the Rhododendron plantation east of the reservoir, is the highest in lime, the soil containing 1.25 per cent, and the subsoil .74 per cent. The remaining samples containing from .26 per cent to .80 per cent.

The potash content of these soils is shown to be from .07 per cent to .40 per cent, twenty of them having .25 per cent or more, which is considered by Hilgard as the minimum of adequacy. In the report of 1902 the use of potash was recommended on The Mall; the amounts found in the samples from this section, Nos. 11 and 12, show .29 and .28 per cent respectively.

In some cases it will be observed that the potash content of the subsoil exceeds that of the surface soil. In their present condition in many of the

lawns, this and the phosphoric acid in the subsoils is unavailable for the use of the shallow rooted grasses, but is easily reached and utilized by the deeper penetrating roots of the shrubs and trees, where the conditions of drainage and aeration are sufficient to induce a good root development.

The amount of phosphoric acid found in these samples ranges from .10 per cent to .35 per cent, the amount found in all cases being equal to or in excess of the minimum of adequacy established by Hilgard. While the results of these analyses completely refute the oft repeated statement that the Park soils are worn out or exhausted of their mineral plant food, it does not mean that it is proper or wise to withhold application of manure or commercial fertilizers in the care of these lawns.

The results of these analyses show very clearly the fitness of the soils in Central Park for the purposes to which they are put, and we must look for some other cause for their present condition, and some other remedy than resoiling.

PRESENT CONDITION OF THE LAWNS

The occurrence of stooling grasses and weeds in the lawns was sufficiently marked to cause their presence to be noticed in the report of 1908, wherein suggestions are made for their eradication. This report having called attention to the presence of plants of this character in the lawns, shows that their advent is not of very recent date. At that time, too, the condition of many plants of this character which have since developed into colonies, must have been such that their eradication, with trowel or spade was perfectly feasible even if it was not deemed advisable to carry out the suggestions made in that report for the complete renovation of the lawns. The report of the Committee of the Parks and Playgrounds Association, is silent in regard to the actual condition of the greensward. The report, however, advocates resoiling and submits an estimate of the cost of this treatment, the same figures that were presented in 1907 when this project was first advocated.

The general appearance of the lawns has given rise to much comment during the past year. Their condition has been ascribed by many to a worn out or exhausted condition of the soil, or to its not being suitable for the growth of grass. While the conditions are in most cases far from satisfactory, I think that but little blame can be properly laid on the soil itself, for their existence. That the soils of the Park are capable of maintaining a good growth of grass has been definitely proved by their past history. They are today maintaining some good grass in spite of neglect that is apparent to even the casual beholder and to which they have apparently been subjected for many years.

On some of the lawns devoted to games of various kinds, all growth has been destroyed in spots by trampling, a natural result of the uses to which the lawns are put. The brown and dead-looking spots, however, in many of the lawns are the result of the intrusion of various plants that come up in the spring, bloom and make their seed and die down by the following autumn.

At this time the greenest lawns in Central Park are those upon which the presence of weeds is most abundant. In some of the lawns the limited amount of grass is startling though the whole lawn now presents a vivid and lifelike green color. Particularly is this the case at 106th Street and Eighth Avenue, where the whole lawn is a solid mass of *Achillea Millefolia* (Man's Balsam) in which may be found a scattering of grass. Moreover, the sod used to cover the face of the bank sloping down from the lawn to the drive at this point is of the same character. North of 79th Street and west of the Reservoir, in the area on both sides of the west drive, as far north as 86th Street, twenty-one varieties of weeds and five varieties of stouling and otherwise undesirable grasses were found in the lawns. Not single specimens, but colonies occupying from a square yard to many feet across, not one of which could not have been exterminated long before they reached their present proportions, had proper vigilance been exercised in watching over the lawns. In this section some of the more persistent weeds that are exterminating the desirable grasses are sour grass, blood veined dock, toad flax and chickweed or mouse ear. In this section of the Park, not only these plants have a firm hold, but there are also thriving colonies of gall of the earth and crab grass.

On the east side of the reservoir in the vicinity of the Museum of Art, there is now on the whole an excellent stand of blue grass, which in the vicinity of the Hamilton Statue, just across the drive, gives way to a mass of weeds.

Many other instances could be cited, such as the slope along the West bridle road, where dandelion and chicory (*Chicorium Intybus*) are found in profusion, but it would simply be a repetition, for there is scarcely a lawn in the whole enclosure that is not carrying a full load of undesirable plants. Moreover, in every portion of the Park, notably along the lake bank, and among the shrubberies, clusters of wild garlic (*alium vineale*) are to be seen and in some cases it has spread to the adjacent grass areas.

The habit of many of these intruding plants is indicative of a preference for land low in lime in some cases, and for damp or illy drained areas in others and their presence alone is a fairly reliable indication of the treatment necessary to effectually get rid of them. Their mere removal, however, will do but little good unless in the future, greater care is exercised in keeping the lawns in proper condition by eradicating weed growth as it appears.

In some cases where lawns have been reconstructed or regraded, the earth has been filled in around the bases of the trees to a considerable depth. Occasionally a basin-like depression has been left around the tree as shown in the accompanying photograph, in which the white spot on the tree trunk shows the height of the surrounding filling. Both of these methods are damaging, usually fatally, to the trees. In one case, the layer of moist earth and in the other, the water which collects in the depression at certain seasons, has a tendency to keep the bark constantly wet, causing it to rot or loosen. Few species of trees will put out adventitious roots in the added soil, and the proper method to follow where there are existing, well-estab-

lished trees, is to so arrange the grades as to avoid the necessity of filling in around them.

The complete renovation of the lawns in Central Park must include an extension or overhauling of the present subdrainage system, where it is not of recent installation, as well as the construction of new lines. Also the extension of water mains, or laying of new ones, to provide for the future care of the lawns. After the completion of this work, the lawns if greatly infested with a weedy growth should be plowed and turned well under. If this work can be done by the early summer, as soon as the plowing is completed, apply from 750 to 1,000 lbs. of lime per acre; then harrow in so as to distribute the lime evenly throughout the surface layer. Allow land to stand for several days and apply 1,000 to 2,000 lbs. finely ground limestone per acre, and disc and harrow thoroughly. The liberal use of manure is also recommended at this time. Sow to crimson clover and allow this crop to grow on throughout the summer and to occupy the ground during the following winter. In the following spring, plow under the clover and add 1,200 to 1,500 lbs. ground phosphate rock (Floats) per acre. Disc and harrow the ground until a fine seed bed is obtained, applying at this time, a fertilizer carrying 2 per cent nitrogen, 6 per cent phosphoric acid, and 8 per cent potash, at the rate of 500 lbs. per acre. This should be drilled in and the ground well harrowed to insure an even distribution. Smooth and level lawn and sow to blue grass with a little white clover. Roll after sowing.

If the plowing has to be deferred until later in the summer, omit application of lime at this time, but use manure, limestone and phosphate rock. Sow to rye, in the fall, and allow it to grow over winter. In the spring while growth is green and succulent, plow the rye under and apply lime. After a lapse of a week or ten days, apply fertilizer and sow grass seed. Much depends upon the preparation of the seed bed, and the discing and harrowing cannot be too thorough. Along the wooded borders, and in some cases where the lawns are thickly set with trees, as is the case on The Mall, these areas will require spading instead of plowing, to avoid injury to the tree roots.

In many cases there are small lawns, which after plowing could be heavily manured, treated with lime, limestone and phosphate rock and sodded. Sufficient sod for this purpose could easily be obtained from portions of some of the areas, where intruding weeds have not yet found a foothold. It has already been pointed out that certain recently sodded areas are now covered with weeds, which probably were present in the sods at the time of laying them. The use of sod taken from selected areas in the lawns would avoid this and insure a stand of good grass instead of weeds. If the work is to be done at all, it should be done with a view to thoroughness and permanency, and in my opinion, less money than heretofore recommended for resoiling, if spent for the renovation of the lawns in this manner, would give results that would prove far more satisfactory than if expended for the purpose of new soil.

Equally important with the thorough preparation of the land in the establishment of a lawn is its subsequent care. Not only must vigilance be exercised to eradicate weeds as they appear, but in the matter of fertilizing as well. But little commercial fertilizing materials appear to have been used on the lawns, the purchase of this class of material being confined to a small amount of wood ashes. Recently pulverized sheep manure has been used to a limited extent as a spring application.

TOP DRESSING LAWNS

Top dressing in the fall or winter is recognized as a necessity in the care and preservation of lawns. The manure used for this purpose should be fine and well rotted, and should be distributed over the lawn in an even layer, so that it can be carried beneath the surface of the grass by the rain and snow. Manure of this character will not disfigure the lawns in winter, nor leave any great amount of trashy material to be removed in the spring.

In the treatment of the lawns in Central Park, judging from their appearance in March, 1911, the manure applied the previous fall and winter was neither well rotted nor was it evenly distributed. On the lawns which had been top dressed, it was to be seen scattered over the grass in a very lumpy condition, a considerable proportion of the grass receiving little or none at all, while in spots it was still remaining from two to four inches in depth. I am informed that this method has been practiced for some time, the custom being to break up and distribute the manure remaining on the ground in the spring, by the use of brush harrows. During this operation much of the trash is removed also. Advocates of this method claim that the soluble portion of the manure is distributed by the action of the snow and rain and that in effect it is as beneficial to the lawns as when care is taken to secure an even distribution at the time of its application.

The general appearance of the lawns as they are starting into growth does not support this theory. The comparative starvation of the spots over which no manure is spread is in itself a cause for an unevenness of growth, a condition which is greatly accentuated by the stimulated growth of the grass on the spots upon which the manure has found lodgment. This is in itself a sufficient cause for the ragged appearance frequently seen and cannot be wholly rectified by mowing, for the stronger roots of the amply nourished portions continue to grow more vigorously during the whole season. Moreover, when more deeply covered the protection afforded by the deeper layer of materials keeps the spots so protected from freezing until later in the winter, and prevents their thawing as early in the spring as the unprotected areas, tending to produce a marked inequality in the temperature of adjoining spots, resulting in unequal "heaving" and the subsequent tussocky or lumpy conditions sometimes seen in lawns that have been given this treatment.

Arrangements have been recently made, by which the park authorities obtain, at the cost of hauling only, the manure produced in a stable of about 500 horses. With this source of supply and the short distance it has to be

hauled, this is most advantageous for the Park Department, and insures an ample supply for its needs at a minimum of cost. The present facilities for caring for this material are such as to insure its being in proper condition when needed for use.

Not only should the manure used for top dressing be finer than that at present used, but it should be more evenly distributed. Application of commercial fertilizer, or of nitrate of soda, should be given in the spring when the grass is starting into growth.

Whenever weeds make their appearance, they should be removed at once, the ground lightly spaded, fertilized and reseeded to grass. Frequently the amount of work of this kind needed on a lawn is slight at any one time; failure to take these precautions results in the disfigurement and ultimate destruction of a lawn. The bare spots under many varieties of trees will, in many cases, yield to treatment of this kind, and by persistent effort good grass can be made to grow among much of the shrubbery where the plantation is not too dense.

PURCHASE OF SOIL

During the progress of this investigation, my attention was directed to the unsatisfactory results following the purchase of soils under certain contracts. It has been the practice in past years to purchase the soil needed for use in the various parks and plats, by contract; in one instance bids were invited to furnish "Garden Mould" for use in lawn construction and for tree-planting, which was to comply with a specification that required it to contain "at least 15 per cent of natural decayed organic matter, and not more than 57 per cent of sand, the balance in per cent to be made up of clay, phosphoric acid, potash, lime, and ammonia in the form of organic nitrogen." As will be seen, the chemical and physical constituents of the soil are in a hopeless tangle. The unfortunate use of the words "at least" in regard to the organic matter and "not more than" in reference to the sand, rendered it quite possible to supply under this specification the same material that in other cases was furnished under the name of "Organic Mould or Humus." The further provision that the balance in per cent is to be made up of clay, phosphoric acid, potash, lime and ammonia in the form of organic nitrogen, being a jumble of the chemical and physical make-up of soils, is absolutely meaningless.

It has also been the custom to purchase soils of different character and to mix them with the idea of obtaining a soil which should be suitable in its composition, the materials used being required to conform to the following specifications:

CLAY LOAM

The clay loam furnished must be fertile earth from cultivated fields showing cultural results satisfactory to the Department. It must be fine (60% to pass through a sieve 50 mesh to the inch) free from stones, roots and weeds, alkaline and must contain when dry at least 35% clay, 6% organic matter, and the balance sand or grit.

ORGANIC MOULD OR HUMUS

The organic mould furnished must be well disintegrated sun dry humus from land under cultivation showing cultural results satisfactory to the Department. The mould must be free from foreign matter, alkaline and contain when dry at least 80% well decayed organic matter, 3½ ammonia, and 8% lime as carbonate. The balance sand, grit or clay.

These specifications are objectionable in many respects. The requirement that the soils be taken from "cultivated fields" in one case, and from "lands under cultivation" in the other, is too great a restriction upon the Park Department itself. By its own action it prohibits the tender of bids to furnish soil in every way suitable for its uses if it is found in a virgin state. This restriction is emphasized by the further requirement that the fields from which it is proposed to obtain the soil "must show cultural methods satisfactory to the Department." This further restriction would exclude soils from permanent pastures or old meadows that may have been producing good grass for many years.

In effect, it confines the selection to soils from abandoned gardens or farms, for it is not likely that even the most unthrifty farmer would seek to even temporarily increase his revenues by disposing of the soil from his fields. The specifications moreover, place no restriction whatever on the depth to which the soil may be taken, making it possible to supply under them, subsoil as readily as surface soil.

The requirement that the clay loam shall contain at least 35 per cent clay, without reference to the amount and character of the remaining material is too indefinite, for under the specification as drawn, the soil may contain any amount of clay in excess of 35 per cent.

The provision that 60 per cent must pass through a sieve of 50 mesh to the inch would, if taken in connection with the former requirement, permit the use of a soil composed of 35 per cent clay, 40 per cent coarse sand or gravel, and the remaining 25 per cent such grades of silt and sand fine enough to pass through the sieve which could hardly be called a clay loam.

The specification for "Organic Mould or Humus" calls for "well disintegrated sun dry humus from land under cultivation," a substance which may be considered as non-existent.

Humus is the name applied to a complex substance, made up of a number of chemical compounds, resulting from the breaking down or decomposition of organic matter in the soil. It may with propriety, be considered more in the light of a condition, or state of decomposition of the organic matter in the soil, rather than as a definite body susceptible of isolation from the soil itself and capable of being offered as a marketable commodity, as distinctly required by the specification. It is worth while to mention that the analyses of the samples submitted with bids to furnish this material, have in every case examined, reported it not as containing so much "humus," but so much "Organic Humus Material" which it is, and of which no better example could be found than stable manure.

The material furnished under this specification is a muck soil. A soil of this character consists largely of the remains of previous generations of vegetation in various stages of decomposition, the vegetation from which it is derived having been produced in low damp places with little or no drainage, or under swampy conditions. The mineral matter of these soils being the result of outwash from the higher surrounding lands or by deposition from water.

At present, owing to the unusual activity of those having this material to sell, the most extravagant claims are being made for it, and its use has become a fad. In spite of the many claims for it, there are many purposes for which it is entirely unsuitable, and it is not a competent substitute for manure.

It has, for some time past, been the practice to make separate purchases of the materials supplied under these specifications and to attempt to mix them, in about the proportion of 70 per cent of the clay loam, and 30 per cent of the so-called humus. The results in all cases observed, have been far from satisfactory. The thorough mixing of soils of such a vastly dissimilar character, is well nigh impossible and where attempted, after a short time, the muck is usually found as an accumulation at or near the surface, from which when dry, it is readily blown by the wind or washed off by the rain. If a permanent mixture could be accomplished the resulting soil is, owing to the character of the muck, too light and spongy to give a sufficiently firm setting for trees, and there is no reason why a soil destined for the growth of grass and shrubbery should contain such an amount of organic matter. If an increase in the organic content of a soil is necessary, it is better to secure it through the use of stable manure. The nature of this material and the processes of decomposition which it passes through, aided by natural agencies will result in the formation of humus and its more thorough distribution throughout the entire soil mass, than can be otherwise effected. Moreover, the processes of decomposition through which the manure passes while in the soil result in products that combine with or act on the mineral matter of the soil in various ways, during the various stages of decomposition.

The addition of a muck soil, containing upwards of 80 per cent of organic matter that has already passed through many stages of decomposition, and which has at many stages been subjected to the action of water by which most of its soluble matter has been removed, can be of but little benefit to any soil compared with that derived from the use of organic matter, decomposing and reaching a state of humification while incorporated with the soil itself.

Soils do not run with the uniformity that permits of a restriction to a limit of one or two per cent of the various sized particles that it is composed of. This fact is well recognized by authorities on soil classification and the admitted variation in the amount of clay, silt, or of the finer or coarser

sands in a given type of soil, is quite considerable, and the limits that are required may be exceeded by a small margin without affecting the character of the soil, if all sized particles are present in proper proportion. As will be seen the specification for clay loam calls for at least 35 per cent clay, but makes no mention of the size and character of the remaining mineral material. Two soils each containing the minimum amount of clay, but the remainder in one case being made up largely of silt and the finer sands, and in the other of the coarser sands with little or no silt, will be found to be very different soils, though each would comply with the specification as drawn.

If a specification of this character is considered necessary it should be so drawn as to show the limits between which each class of soil material must fall. To require compliance with these would, however, necessitate numerous analyses and permit the rejection of many soils well suited for the use of the Park authorities, because of even very slight variations in their composition.

On the other hand, the texture of the subsoil may be so similar to that of the surface soil, that notwithstanding its unfitness for use, would pass the analytical requirement. This is the case with the Hempstead loam, a soil found on Long Island, the typical sample of which analyzes as follows:

Size of Material	Soil	Subsoil
Clay	21	20
Silt	48	46
Very fine sand.....	11	13
Fine sand	5	5
Medium sand	4	5
Coarse sand	7	8
Gravel	3	3

I would recommend that whenever soil is needed for use in the parks:

1. That a sample of the soil proposed to be furnished be submitted with the bid, together with a statement showing the average depth of the surface layer, the location where the soil is to be obtained, and a sample of the subsoil.
2. That the soil supplied be required to be top soil only, taken to a depth that by change of color or other characteristic, such as absence of disturbance by cultivation of the surface soil, etc., marks the distinction between the surface layer and the subsoil.
3. That each load be subject to inspection by the Park authorities, rejection to follow failure to agree with the sample in all characteristics, discernible in a field examination.

The most efficient inspection can be secured at the place where the soil is dug. The detail of a competent person should be made for this purpose whose duty should be to see that top soil only was taken, and that it was equal in appearance, feel, etc., to the sample submitted, and that soil containing subsoil, trash or an undue amount of gravel, stones, etc., be rejected.

WATER SUPPLY AND DRAINAGE

The construction of a system of water distribution was recommended by the Committee in their report in 1902. That in the eight years that elapsed between that report and the investigations of the Committee of the Parks and Playgrounds Association in 1910, but little was accomplished towards this end, is very clearly shown by the latter report, which states: "Central Park is today without an efficient (water) system for proper maintenance," and further states that through lack of water thousands of shrubs died outright and many trees were practically destroyed.

At the present time a considerable part of the Park is not reached by the pipes of the existing system. A recent test of a very efficient spray nozzle develops the fact, too, that there is in the partially completed system now in use, too little pressure to give the most effective results. Not only should the mains and system of distributing pipes be so extended as to reach all portions of the park, but means should be taken to secure the necessary increase in pressure.

Abundant measures have been provided for the disposition of surface water, and an under drainage system could easily be arranged and the drainage water led into the basins, etc., already provided. In disposing of the surface water from walks and drives it has in some cases been led directly on to the lawns and this practice is directly responsible for some of the unsatisfactory conditions noticed. At a point just inside of the 103rd Street gate, on the west side, the whole surface drainage of the higher land to the northward was directed on to a lawn that was made within the last year or two, with the result that it was greatly eroded and practically destroyed, quite as much work being necessary to restore it as was required in its original construction. This is also the case on the walk along the north side of the "North Meadow" where the water is already cutting into the soil, and at a point on the walk adjoining the East Drive near the junction of the walk leading to the dairy.

The necessity for a more adequate system of under drainage throughout the entire Park is very apparent. Tile drains have been laid from time to time in various portions of the enclosure, but there still remains a number of places where the need of some system of sub-drainage is urgent. In some of these cases the existing lines have been in place for many years and have become inoperative by reason of regrading or filling in of lawns, or by the tiles becoming clogged up. In others no drains appear to have been laid.

It should be distinctly borne in mind that the introduction of an under drainage system does not mean the removal of surplus water only. On the contrary, it means an improvement in soil conditions in many ways, which is impossible of attainment while the present conditions are permitted to exist.

Under drainage is needed in the ball ground, the green, and the north meadow particularly, and in many of the less extensive areas throughout the Park. In the case of those lawns which have been subjected to an undue amount of trampling, as a result of their use for baseball, tennis, etc., at

times when the ground is too wet, there has been developed a puddled condition of the soil just below the zone occupied by the grass roots, that seriously interferes with the downward passage of the rain as it falls, as well as with the upward movement of the water that eventually penetrates it. Owing to the generally level topography of these areas, the off-flow by surface drainage is slow and the condition of the soil causes the surplus water to remain standing in many places on these lawns for a considerable time. The introduction of a system of tile drainage in these areas would not only result in a great improvement in the condition of the soil structure, making it more permeable to air, etc., but would go far towards improving their future appearance, as many of the weeds now growing in these lawns would disappear if their present wet condition were corrected.

The present condition of several other large areas also indicates poor under drainage. The area on the east side from 92nd to 102nd Streets east of the drive, and that west of the reservoir from 79th to 86th Streets, need an extension or overhauling of the existing systems. In the reconstructed lawn adjoining the drive at 100th Street West, standing water was constantly seen during the months of March and April, the tiles which have been in place for years probably being inoperative as a result of the filling in of this area. The lawn just east of the West 106th Street gate could be materially improved by this means, as the introduction of a properly arranged tile drainage system would induce the water falling upon the surface to take a downward course instead of flowing rapidly off the surface. This would also obviate the necessity of employing the present hillside ditch to protect the recently constructed embankment. The net effect of this ditch being to change the locality of the wash, but not to stop it.

Besides these more important areas, there are numerous smaller ones that are in need of improvement by this means. Observations made in the early spring and somewhat later, while preparations for tree-planting on The Mall were being made, show clearly the necessity for drainage of this portion of the Park. From all that can be learned of the early history of this section, a single line of tile was laid through it at the time of its construction, or shortly afterward. When the trees were planted, a row of elms was set directly over this line of tiles, which were subsequently thrown out of alignment by the development of the tree roots and the whole line disarranged.

During the early part of the season, the soil in portions of The Mall, shown on accompanying sketch, was decidedly wet and soggy as compared with the surrounding soil, and seepage water collected in the holes dug for tree-planting at the points indicated. A heavy rain falling in the latter part of March also showed that the movement of water through the lower layers of the soil of this section was extremely sluggish, the water remaining in the holes for several days. In one of these holes an open end of the original tile was for over 48 hours below the surface of the water, but did little, if anything, to assist in draining it. Practically all of the trees that have died were planted within the limits of the area noted, and were doubtless affected by the water-logged condition of the subsoil.

Owing to the topography of The Mall and the adjoining lawns, and the presence of existing surface water drains, these conditions could easily be remedied. Lines of tiles should be laid the entire length of The Mall, as well as through the adjoining lawn on the east, which would remedy the present conditions and materially benefit the general health of the grass and trees in the future. This treatment, together with the spading and manure recommended by the report of 1902, should be given this section without delay.

SHRUBBERY

The general health and thrift of the shrubbery in the thickly planted borders and areas would be greatly benefited by allowing the leaves to accumulate upon the ground as they fall, thus forming a natural mulch, which would serve as a protection for the roots, prevent loss of water by evaporation during times of drought, and by their decay keep up the humus content of the soil. This is, however, practicable only in those spots where the plantation is sufficiently dense, or the locality so situated as to prevent the leaves being scattered by the wind over the adjoining lawns and walks.

In many of the areas in Central Park where the plantations are so dense as to interfere with the maintenance of a good growth of grass, they are yet too open to permit of the accumulation of leaves, without great risk of having them blown about by the wind. The present condition of these spots is, by reason of the absence of grass, unsightly and their bare appearance gives rise to much comment of an unfavorable character. The bordering of these areas by an additional planting of shrubs of a low-branching or recumbent habit, either deciduous or evergreen, would serve a double purpose. This would not only prevent the disturbance or removal by the wind of the greater mass of leaves falling within the limits of the plantation, but would screen from view the somewhat unsightly areas between the general mass of shrubs.

It is not intended that the accumulation of leaves should take the place of manure in the treatment of these areas, but that it should be supplemental thereto, and in addition to these accumulations a good top dressing of manure should be applied as early in the spring as possible, and lightly spaded in. In some of the areas the soil has become very compact and tends to cause the rain water to flow off instead of sinking in the ground. These would be greatly benefited by being forked or spaded to a depth of 4 to 6 inches, early in the spring, and being heavily top dressed with finely broken-up manure. By this means the soluble portion of the manure would be carried into the feeding zone of the plant roots and the remainder would form a mulch on the surface. The surface of these areas should be kept lightly loosened with hand rakes during the summer months, in order to prevent a loss of moisture. Permitting the leaves to accumulate during the fall, and the use of a top dressing of manure put on early in the winter, will help to improve the condition of the soil when once it is secured and it will probably not be necessary to use the spade or fork for several years.

In the report of 1902, the Committee recommended careful and competent pruning, and the Parks and Playgrounds Committee in 1910 comment on the fact that the shrubbery has received bad or no pruning.

Much of the pruning that has been noticed during the present spring warrants the comments previously made, and the result as shown in accompanying photograph is quite general where the shrubbery has been cut; a result that adds nothing to the thrift of the individual shrub, nor to the beauty of the group.

RHODODENDRONS

Much comment has been made upon the failure of the rhododendrons in Central Park to make a satisfactory growth.

The present condition of many of these plants is due to an unfavorable situation, particularly in places on the east side of the reservoir and on the western edge of the plantation near 106th Street West, where they are exposed to too much direct sunlight. It will be noticed that those along the north side of the reservoir and in the interior of the other plantation, where they are more sheltered from this influence, the foliage has a better color. In many instances, the death of the plants has been the result of too deep planting. The rhododendron belongs to a class of plants which are surface feeders and delight in an acid peaty soil largely composed of decaying leaves. In many cases observed the planting has been done with a view to having the tops of the plants at the same level, regardless of the depth to which the roots have to be placed, to obtain this effect. In some cases investigated, removal of the dead plants disclosed the fact that the entire mass of roots and a part of the main stems are imbedded in the underlying soil, and over this was a mulch of leaves. The accompanying photograph is illustrative of a number of cases observed where the plants may not improperly be said to have been suffocated, as a result of the manner in which they were planted. Notwithstanding the preference of this class of plants for acid peaty soils, which, while retentive of moisture, are freely permeable to air, the soil sample submitted by the Committee of the Parks and Playgrounds Association from the "Sage Plantation" contained more clay and silt than any other sample submitted by them, and while also highest in organic matter and humus, contained over twice as much lime as any other sample submitted by that body. The amount of lime found in the samples taken during the present investigation from this area, was also much greater than that found in the majority of the Park soils.

It has also been the custom to dump the coarse strawy refuse of the manure used on the lawns among the rhododendrons, after its removal in the spring. In some cases, it is observed to be 8 to 10 inches in depth. The decay of this material does not give rise to the same peat-like conditions that result from the decay of fallen leaves, and the practice should be discontinued. It is very evident that the plants are not being benefited by it.

The lack of a nursery in which a sufficient stock of trees and shrubs could be carried to supply the needs of the Park, is a serious drawback. At present, all stock needed is bought, usually a year's supply at a time, and

delivery is made in the spring. Frequently the delivery is in carload lots, and the arrival of the stock precedes the preparation of the ground for planting; the stock meantime being temporarily cared for in a small section of the Park, which, though called the "Nursery," is not one in fact.

So far as can be learned, no planting is done in the fall; with a nursery at hand, carrying a sufficient stock for ordinary demands, work of this kind could be carried on as required, even if only but one day at a time was suitable.

The annual reports of the officials charged with the care of parks, etc., in many cities other than New York, show that in a number of them, keeping up a nursery is a part of the regular system. In all instances where such is the case, the results have been most satisfactory. There seems no reason why the Park Department of Manhattan should not follow this practice with advantage.

In the estimate of funds necessary to carry on the work of restoration of Central Park, submitted to the Board of Estimate and Apportionment on December 14, 1910, there appear several items covering construction of new buildings, etc., among them a new stable, several comfort stations, playhouses, skate and boat houses, etc., but I do not find any provision for a suitable housing for the entomologist. The importance of this branch of work in the maintenance of a park cannot be overestimated. The work of the entomologist consists in observing the life habits of insects injurious to the trees and shrubs, as well as the proper means for their destruction, and needs for its prosecution, a suitable building with an insectory and greenhouse attached. This is necessary in order that a study of the feeding habits of the insects can be made, and that the effect of various sprays and insecticides upon the various plants, as well as on the insects can be observed during the entire year. A piece of land should be set aside for the use of the entomologist in a suitable locality upon a portion of which the necessary buildings could be erected, and on the remainder a plantation of the various ornamental plants of the park could be maintained. If such a building contained a room in which could be maintained an exhibition of insects, apparatus, etc., for their destruction, and the plants upon which they feed, its educational value would far outweigh its cost of construction and maintenance.

The whole work of caring for the Park exclusive of conservatory and roads, is in the hands of a force of seven foremen, eighty-one laborers, and thirteen drivers. The work of the foremen being supervisory and that of the drivers being taken up with their proper duties, the whole work of keeping up the lawns, etc., devolves upon the eighty-one laborers.

In Central Park there are 525 acres of ornamental grounds, exclusive of water surfaces, roads and drives, requiring attention, besides keeping walks and paths in order, cleaning up waste paper, débris of various kinds, etc. This force is inadequate for the proper care of the grounds, during the summer months, at least, when the care of the grass, etc., requires constant attention, and the hiring of an additional number of laborers during a part of the year, at least, would do much to improve the existing conditions in this respect.

Specific estimates for the necessary work in Central Park were submitted to the Board of Estimate and Apportionment in December, 1910. These estimates included construction of new buildings, improvement of storage yards, water system, etc., amounting in all to \$2,717,000, of which \$1,250,000 is for reshaping lawns, depositing new top soil and otherwise improving the Park. This item, contemplating the purchase of 75,000 cubic yards of soil, and a similar quantity of manure. The present arrangements being such that a sufficient supply of manure is available without the necessity of purchasing it, the entire expense of obtaining it being limited to the cost of hauling, and the substitution of other methods of treatment for the lawns, instead of resoiling, will considerably reduce the amount of money necessary for the rehabilitation of the Park; an expenditure of from \$250 to \$400 per acre, taking into account the whole 525 acres of ornamental grounds, being sufficient for the purpose. An expenditure of \$50,000 a year for the next three years for this purpose should, by the expiration of that time, see the lawns in first class condition.

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